MATERIALS BUREAU

TECHNICAL REPORT 88-2

RUBBLEIZING P.C.C. PAVEMENT-CONSTRUCTION TECHNIQUES AND OVERLAY PERFORMANCE

FEBRUARY, 1988

M.A.P. CODE 7.42-6-88-2

NEW YORK STATE DEPARTMENT OF TRANSPORTATION
MARIO M. CUOMO, Governor
FRANKLIN E. WHITE, Commissioner

TECHNICAL REPORT 88-2

RUBBLEIZING P.C.C. PAVEMENT - CONSTRUCTION TECHNIQUES AND OVERLAY PERFORMANCE

Prepared by

David W. Bernard
Civil Engineer I (Materials)

February, 1988

MATERIALS BUREAU
JAMES J. MURPHY, DIRECTOR

NEW YORK STATE DEPARTMENT OF TRANSPORTATION
1220 WASHINGTON AVENUE, ALBANY, NEW YORK 12232

M.A.P. CODE 7.42-6-88-2

ABSTRACT

In August, 1986, the New York State Department of Transportation constructed an experimental rehabilitation project on Rte. 146 in Clifton Park, NY. The project involved crushing in place (rubbleizing) an existing steel reinforced Portland cement concrete pavement using a resonant pavement breaker. The crushed pavement was compacted with a vibratory roller and used as a base for an asphalt concrete pavement. The project is a two lane roadway approximately two miles long. The construction was monitored, including measurements of the following: seismic vibrations, pavement deflections, noise, and gradation of the crushed pavement. The cost and production of the crushing operation were also recorded. The project was completed successfully and shows good performance after 18 months in service.

TABLE OF CONTENTS

INTRODUCTION

Asphalt overlays are commonly used to restore the riding quality of badly distressed Portland cement concrete (PCC) pavements. Good performance of the overlay, however, is limited by the cyclic thermal contraction and expansion of the concrete slabs, causing horizontal movement at each transverse joint. This movement causes reflection cracks to occur in the overlay over the underlying joints, thereby reducing the effective service life of the asphalt overlay.

New York State has experimented with a new technique (other than conventional asphalt overlays) for rehabilitating deteriorated PCC pavements. The technique involves rubbleizing or crushing the concrete pavement into 1" to 6" pieces and using this as a base for a new asphalt pavement. The equipment used to rubbleize the existing concrete pavement was the PB4, resonant pavement breaker. The PB4 differs from most pavement breakers because it utilizes high frequency (44 impacts per second), low force impacts (approximately 2000 lbs.). Other pavement breakers such as drophammers, whiphammers, or headache balls crack or crush concrete pavements by producing single blows of enormous force. The PB4 also differs from other pavement breakers in that it debonds the concrete from the reinforcing mesh.

Photo #1
PB4 Resonant Pavement Breaker

The rubbleizing technique was tried experimentally in 1986 on Rte. 146, a two lane PCC pavement. The concrete pavement was 36 years old at the time of rehabilitation. The AADT on Rte. 146 is 9,100 vehicles, with 5% trucks. The pavement was 8" thick at the shoulders and tapered to 7" at the centerline. The slabs contained steel mesh reinforcement and transverse joints were spaced at 95' intervals. The pavement was constructed on 12" of subbase, however a few non-draining locations were encountered. The travel lanes were 11' wide for a majority of the project. A section of pavement from a 26 year old project was also included. This 300 ft. section at the west end of the project had two 12 foot lanes, and was 9 inches thick with 60 ft. long slabs.

CONSTRUCTION SEQUENCE

Shoulders

The initial construction operation involved removing the existing shoulders 8" deep to the bottom of the pavement slab, approximately 8' wide, to daylight both sides. A crushed stone subbase course (Type II, Item 304.03) was used to replace the shoulder material creating a free draining section from shoulder to shoulder once the pavement was fractured. The original 11' travel lanes were also widened to 12' using this crushed stone. A "bath tub" section, in terms of drainage, would be created if the pavement was crushed and the existing shoulders remained. Once travel lane construction was completed, additional crushed stone and asphalt cement concrete were used to reconstruct the shoulders.

Crushing Operation (Rubbelizing P.C.C. Pavement)

The unique aspect of this resurfacing contract was the use of a resonant pavement breaker to reduce the concrete pavement to a crushed stone like material suitable for overlaying. The resonant pavement breaker (PB4) utilizes power transmitted through a 6.5"x18", 12 foot long forged steel beam. At the back end of the beam, hydraulically driven eccentric weights convert circular motion into vibratory motion transmitted to the breaking shoe at the front of the machine. The breaking shoes moves through an amplitude of 1.25" to 1.5" at a rate of 44 impacts per second. The high frequency, low amplitude of movement, and the relatively low impact striking force, is said to minimize the effect on underground utilities or foundations.

Photo #2
PB4 rubbleizes concrete pavement lane adjacent to previous days construction

Compacting the Crushed Pavement

The equipment originally specified to compact the crushed pavement was a static, steel drum roller (10 tons). A dual drum vibratory roller was available and used in the static and vibrating mode. The vibratory mode gave better results. The vibrating drum kneaded the broken pieces together and produced a surface suitable for overlaying. The dual drum or single drum vibratory roller was used for the remainder of the project, with four passes being judged as adequate compaction. The rubber tire paver had no trouble operating on the compacted material. In a few cases, particularly at transverse joints, the reinforcing mesh came to the surface after crushing. Any mesh exposed above the surface was cut off flush using hand tools. At a few midslab locations and at transverse joints, partial depth asphalt patches were removed and replaced with crushed stone.

Asphalt Overlay

The original concrete pavement was crushed and compacted, and used as a base for an asphalt pavement. A 300 ft. full depth removal area was located approximately in the middle of the two mile project.

The asphalt pavement courses are given in the table below. The asphalt paver operated off a ski for grade control. A control section of 300 ft. adjacent to the full depth removal area was left unbroken receiving a 4.5" asphalt overlay.

Asphalt Pavement Thickness (inches)

Location	Length	Pavement Layers*					Shoulders	
		1st	2nd	3rd	4th	Total	stone	A.C.
West End	4000'	1.5" Binder	1.5" Binder	1.5" Top	–	4.5	–	4.5"
East End	6500'	1.5" Binder	3.0" Base	1.5" Binder	1.5" Top	7.5	3.5"	4.0"

*Layers represent dense graded, compacted overlay courses.
Cross slope: of pavement = 1/4"/Ft., of shoulders = 3/4"/Ft.

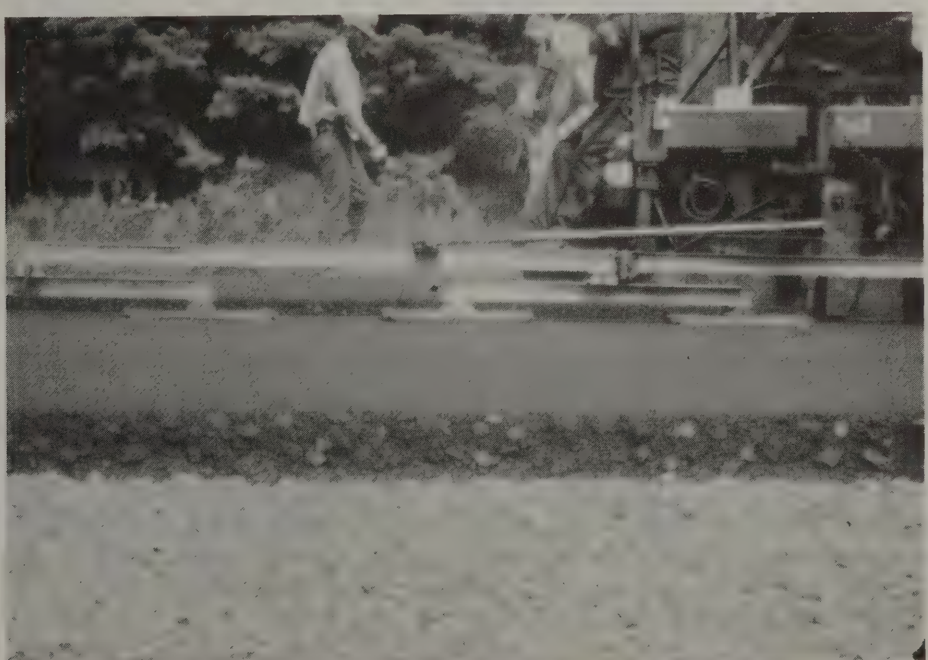


Photo #3
Asphalt pavement being constructed over crushed and compacted concrete pavement

Traffic Protection

Rubbleizing was limited to one lane at a time. The crushing operation utilized one machine which completed approximately 1/2 mile, per lane, per day. Traffic was directed over the adjacent lane as crushing continued, using flag persons at each end. Before the completion of each days construction, the crushed pavement lane was overlaid with 1.5" of dense binder. This allowed traffic on both lanes overnight and held the rubble in place until further layers could be placed. The pattern was reversed the following day. The 1/2 mile portion of the eastbound lane was crushed and overlaid one day, and the adjacent westbound lane was completed the next day.

CONSTRUCTION OBSERVATIONS

Water trapped in the subbase below any pavement is a serious problem. When concrete pavements are unbroken, the slabs will "bridge" over weak, wet subbase locations. However, when the pavement was crushed in place into coarse aggregate size pieces, and wet areas existed below it, the crushed pavement quickly became unstable. Heavy construction equipment deflected the unstable pavement several inches. Any overlay placed over this condition quickly developed deep wheel ruts. In these cases, subbase drainage was <u>ABSOLUTELY</u> necessary to dry out the subbase and stabilize it along with any pavement layers above it. Wet areas were discovered after crushing the pavement and excessive deflections occurred under heavy construction equipment. In one known wet area, the pavement was only partially crushed to help bridge the unstable subbase, in addition stone weeps were provided for drainage.

Production

Initially, the machine was operated at a relatively slow speed (less than 1 mph). At this slow speed, it was assumed the PB4 would only require one pass over each area to fracture the pavement. However, the PB4 was not designed to operate at slow speeds, and at 1 mph, the machine experienced excessive vibrations. It was agreed to experiment with faster breaking speeds, however, two passes were required over each area to be broken. Two passes resulted in a crushed stone material meeting the specifications, but at a slower production rate. The average production achieved was approximately 245 s.y. to 290 s.y./hr.

Cost

The price bid for the crushing operation was $2.25/sq.yd. The total quantity of pavement crushed was 25,800 sq. yds.

Breaking Pattern

The slab breaking pattern did have some effect on the end product. After experimenting with several different patterns, it was determined that starting at a free edge (shoulder) and working inward to the longitudinal joint produced the best results. Following this pattern provided "relief" or created room for expansion of the concrete pavement. For the two lane pavement, the complete breaking pattern was as follows: Begin at the shoulder, breaking inward to the longitudinal joint. The following day, begin at the longitudinal joint adjacent to the previous day work, and break outward to the other shoulder.

The PB4 crushed nicely as long as it snaped off a 6" edge from a large slab. However, when crushing began at the longitudinal joint and moved outward, the slab continued to get narrower until it was only a thin strip. The machine couldn't snap off a 6" edge from a 2' wide strip, which created 1'-2' square pieces at one shoulder. There was physically no way to avoid this situation which is described as "slabbing", therefore it was minimized by following the breaking pattern described above. The vibrating nature of the breaking shoe couldn't crush individual 2' pieces, it simply drives them down into the subbase.

Creating a Buffer Zone To Separate Crushed Lanes

The construction sequence of the project involved rubbleizing one of the two lanes and overlaying this with asphalt the same day. The first 1 1/2" dense binder course was placed at the end of each day to cover the crushed pavement allowing traffic over this lane at night. The following day, the adjacent lane was crushed to match the previous days production and overlaid. It was found that if the two lanes were not separated by crushing a thin strip between them, the vibration of crushing the second lane adversely effects the overlay placed adjacent to it. Therefore, the first lanes rubbleizing was extended 6" into the adjacent lane to prevent damaging the asphalt overlay.

CONSTRUCTION MONITORING

Seismic Testing

The vibration levels created by the PB4 and vibratory roller were measured during construction using seismic equipment. The purpose of this testing was to determine the possible harmful effects of the pavement breaking operation on sensitive objects such as buried utilities or foundations. Seismic measurements were taken at several project locations. The PB4 created vibrations measured at 1.5"/sec. or less. The vibratory roller produced earthborne vibrations at a maximum of 2.5"/sec. In general, the pavement breaker produced slightly lower velocity and amplitude vibrations than the vibratory roller. It may be concluded the PB4 does not create a greater hazard to buried objects than the vibratory roller. (See Seismic Results in the Appendix and AASHTO R8-81.)

Deflection Testing

Pavement deflections were monitored following the crushing operation and continued as subsequent asphalt layers were added. Since construction in August, 1986, several areas of the finished pavement have been monitored biannually. Pavement deflections were measured using two Benkelman beams, one in each wheel path. The Benkelman beams were placed between the rear tires of a dual rimmed dump truck loaded to produce a 22,400 lb. single rear axle load. The Engineering Research and Development Bureau has concluded any Benkelman beam measurements below 0.020" are considered indicators of stable conditions. The data accumulated indicates low deflection measurements on the finished pavement, generally averaging below .020". In a few cases, deflection measurements recorded on "rubble" or truing and leveling courses were 0.030"-.099", but as addition layers of pavement were added, the deflections decreased to below .020". (See Line Diagram on Page 8 and Deflection Data in the Appendix.)

Noise Levels

The noise levels produced by the PB4 were measured around the machine using Sound Level Meters. Different modes of operation were measured, including crushing, backing, and idling. Measurements were taken in the area surrounding the pavement breaker and in the operator's cab at ear height. (See Appendix, Noise Measurement.) In general, during the crushing operation, the measured noise levels were high, approximately 103 dB(A) in a range from 15 ft. to 25 ft. At 50 ft. during the crushing operation, the noise level decreased to between 91 dB(A) - 95 dB(A). Due to the asymmetry of the unit, noise levels were higher on the side closer to the breaking head (right side). A list of common indoor and outdoor noise levels is included in the Appendix for comparison.

Gradation of Crushed Pavement

The gradation of the crushed concrete pavement can be separated into two categories. In general, the concrete above the reinforcing mesh was crushed into smaller size pieces. The size of crushed material above the mesh averaged 1" to 2" (almost 75% passed the 1 1/2" sieve and 50% passed the 1" sieve). The breaking energy of the PB4 was dissipated at the mesh level (midslab), producing larger size pieces in the bottom 4" layer. Approximately 15% was larger than 4" (40% below the mesh was greater than 2", only 20% passed the 1" sieve). The specification for crushing pavement required the majority of broken pieces to be 1" to 2", the largest not to exceed 6" (See specification in the Appendix). The PB4 did meet these requirements. However, due to the nature of resonant breaking action causing "slabbing", some pieces up to 12" were produced at one edge. Test holes indicated that the pavement was completely debonded from the reinforcing mesh. (See Rubble Gradation on Page 7.)

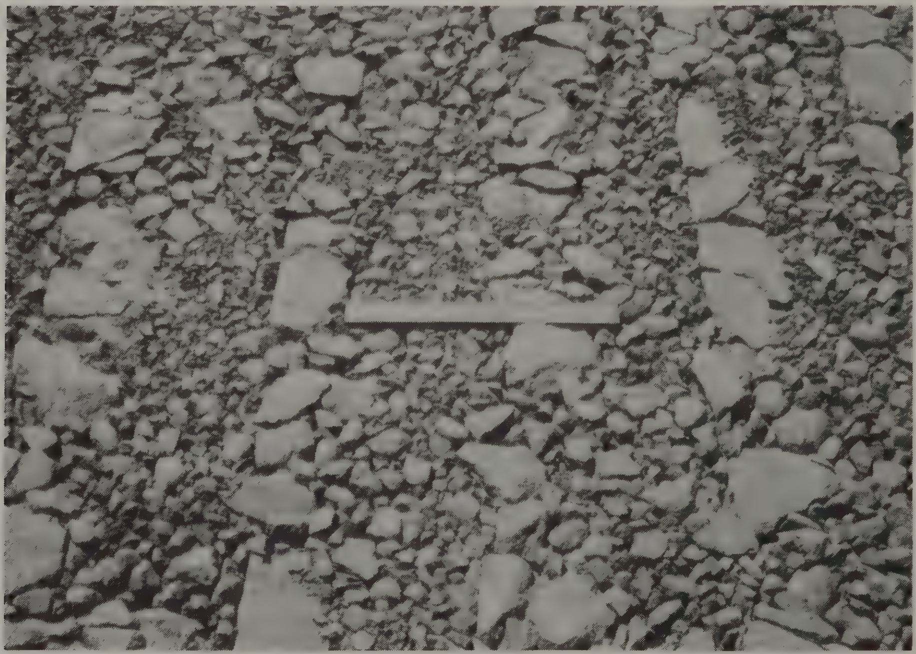
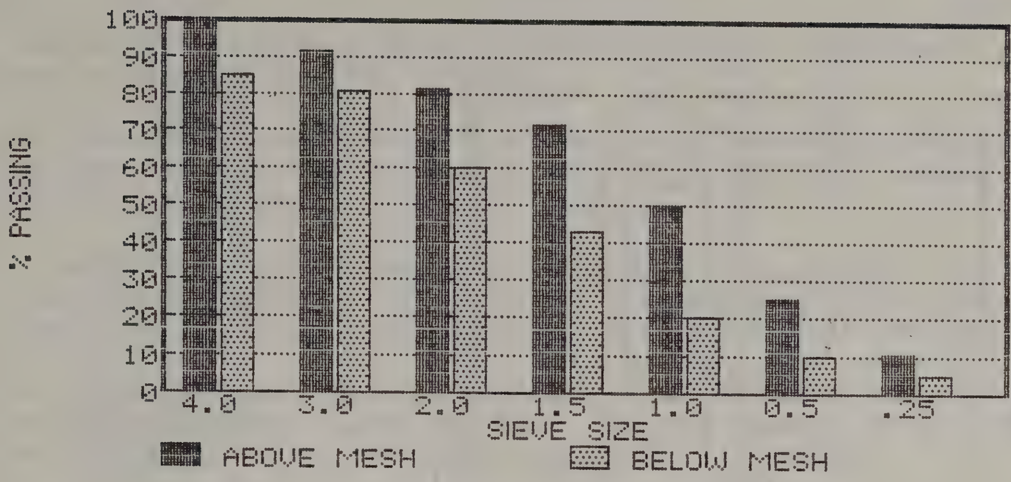


Photo #4
Gradation of the crushed concrete pavement
(12" ruler for scale)

RT. 146 RUBBLE GRADATION



POST CONSTRUCTION

Crack Survey

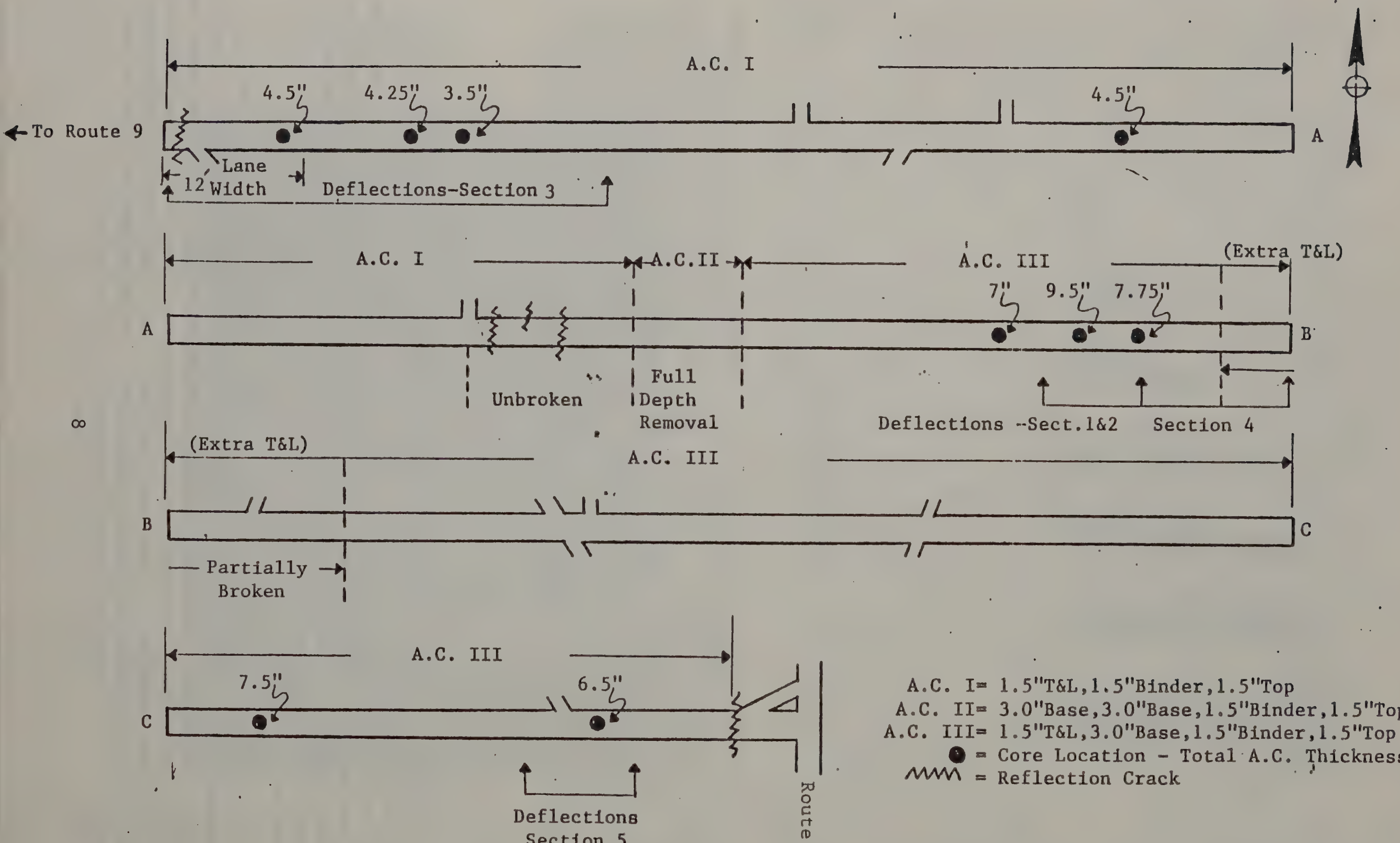
Twelve and eighteen months after construction, reflective cracks were surveyed. In general, the rubbleizing technique was very successful in eliminating transverse reflective cracks. Experience has shown that transverse joints would reflect through the asphalt overlay during the first winter. Two transverse cracks were recorded, one at the beginning and end of the project, marking the transition from broken to unbroken slabs. Transverse reflective cracks found in the control section are expected because the unbroken slabs continue to cause thermal movement at the underlying transverse joints. No longitudinal reflective cracking was found at the centerline or where the pavement was widened from 11' to 12' travel lanes. Reflective crack monitoring will continue.

Deflection Monitoring

The Engineering Research and Development Bureau has continued to monitor long term pavement deflections in areas evaluated during construction. The data accumulated after 12 months is very promising. Deflection measurements recorded on the finished pavement are below .020", the criteria Research has established as indicating stable conditions. Deflections are taken each spring and fall, and the trend shows the crushed pavement continues to be stable. Research will continue to follow deflections in the designated areas until a deflection history is established.

In sections 1 & 2, the initial deflection data ranges from .050"-.10" for measurements taken on the rubble or first truing and leveling course. This happened to be an area with water trapped below the pavement. After drainage was added and the remaining pavement layers were completed, the deflections came down below .020" and continue to stay low. Section 3, 4, 5 all have low deflection numbers for the finished pavement, below .020". (See Deflection Data in the Appendix.)

ROUTE 146 (RTE. 9 - RTE. 236)



NOTE: All of the original concrete was rubbleized and lane widths = 11' except where noted.

CONCLUSIONS

As a result of construction observations and followup performance surveys, the following conclusions have been reached:

1) The Resonant Pavement Breaker is capable of reducing an existing concrete pavement into coarse aggregate size pieces suitable for compaction as a base for another pavement.

2) No reflective cracking has appeared at transverse joints in the rubbleized areas after 18 months. Cracking in the asphalt pavement has also been eliminated at the longitudinal joint where travel lanes were widened.

3) The deflection data and field observations show the rubbleized base is providing adequate support to date. No settlements, rutting, or cracking has been noted in the rubbleized areas after 18 months.

4) Seismic testing during construction showed vibrations produced by the PB4 were 1.5"/sec. maximum. The PB4 pavement breaker does not create a greater hazard to buried objects than the vibratory roller. The vibrations produced by the pavement breaker are isolated to the area below and immediately adjacent to the breaking shoe.

5) Noise measurements during construction indicate ear protection is required of any worker in or near the pavement breaker. Sound levels are comparable to heavy construction equipment.

6) The compacted crushed pavement is capable of supporting paving equipment, construction equipment and cross access.

7) Both asphalt pavement thickness (4.5", 7.5"), used to cover the rubbleized pavement are performing well to date.

8) Traffic can be maintained in one lane as crushing and overlaying continue in the adjacent lane.

9) The asphalt overlay in the unbroken control section developed reflective cracks at transverse joints within six months as anticipated.

10) Edge drains or stone weeps are necessary when non-draining subbase areas are encountered.

11) The forward rate of speed of the PB4 can influence the degree of breaking.

12) A 6" crushed strip should be left between lanes to separate them. This buffer strip reduces the effect of vibrations from one lane to the next.

Recommendations

The Materials Bureau will continue to monitor the performance of the asphalt pavement.

The current specification is being revised by the Materials Bureau to reflect field experience from this project.

Due to the success of the crushing operation, continued low deflection readings and overall good performance to date, this technique is recommended as a pavement rehabilitation alternative.

APPENDICES

APPENDIX A

RUBBLEIZING SPECIFICATION

ITEM 18502.75

RUBBLEIZING EXISTING PORTLAND CEMENT CONCRETE PAVEMENT

DESCRIPTION

Under this item, the Contractor shall rubbleize and compact the existing Portland cement concrete pavement within the payment lines shown on the contract plans.

MATERIALS

None specified

CONSTRUCTION DETAILS

The existing pavement shall be rubbleized with a self contained, self propelled resonant frequency pavement breaking unit capable of producing low amplitude, 2000 foot-pound blows at a rate of 44 per second. The unit shall also be equipped with a water system to suppress dust generated by the rubbleizing operation. The operating speed of the unit shall be such that the existing pavement is rubbleized into particles ranging from sand sized to pieces not exceeding 6 inches in largest dimension, the majority being 1 to 2 inches in size.

Prior to placing the initial asphalt concrete overlay course, the rubbleized pavement shall be compacted with 8 passes of a smooth steel wheel roller having a nominal gross weight of not less than 10 tons and which exerts a minimum force of not less than 300 pounds-per-inch-of-width on the compression roll faces. The roller shall be operated at a speed not to exceed 6 feet per second. Any depressions, one inch or greater, that result from the compaction effort shall be filled with Type CA1 Coarse Aggregate, Type CA2 Coarse Aggregate or Type 2 Subbase Coarse. Filled depressions shall be compacted with the same roller and compactive effort previously described.

Welded wire mesh reinforcement in the rubbleized pavement shall be left in place. However, any mesh exposed at the surface as a result of rubbleizing and/or compaction operations shall be cut off and removed from the site.

Except at crossover and/or access points (intersecting streets, driveways, etc.), traffic will not be allowed on the rubbleized pavement before the initial asphalt overlay course is in place. In no instance shall more than 48 hours elapse between rubbleizing the existing pavement and placement of the initial asphalt concrete overlay course. However, in the event it rains between these operations, this time limitation may be waived to allow sufficient time for the rubbleized pavement to dry out to the satisfaction of the Engineer.

Crossover and/or access points shall be maintained in the same compacted state as non-accessible areas until the initial asphalt concrete overlay course is placed. Maintenance of crossover and/or access points shall be accomplished as ordered by the Engineer.

These preceding operations should be scheduled after widening and shoulder work has been progressed up to the elevation of the existing pavement grade. These areas can then be utilized to support the resonant frequency pavement breaking unit while the existing pavement is being rubbleized and can be completed in conjunction with the placement of asphalt concrete courses over the compacted rubbleized pavement.

METHOD OF MEASUREMENT

The quantity to be measured under this item shall be the actual number of square yards of existing Portland cement concrete pavement rubbleized.

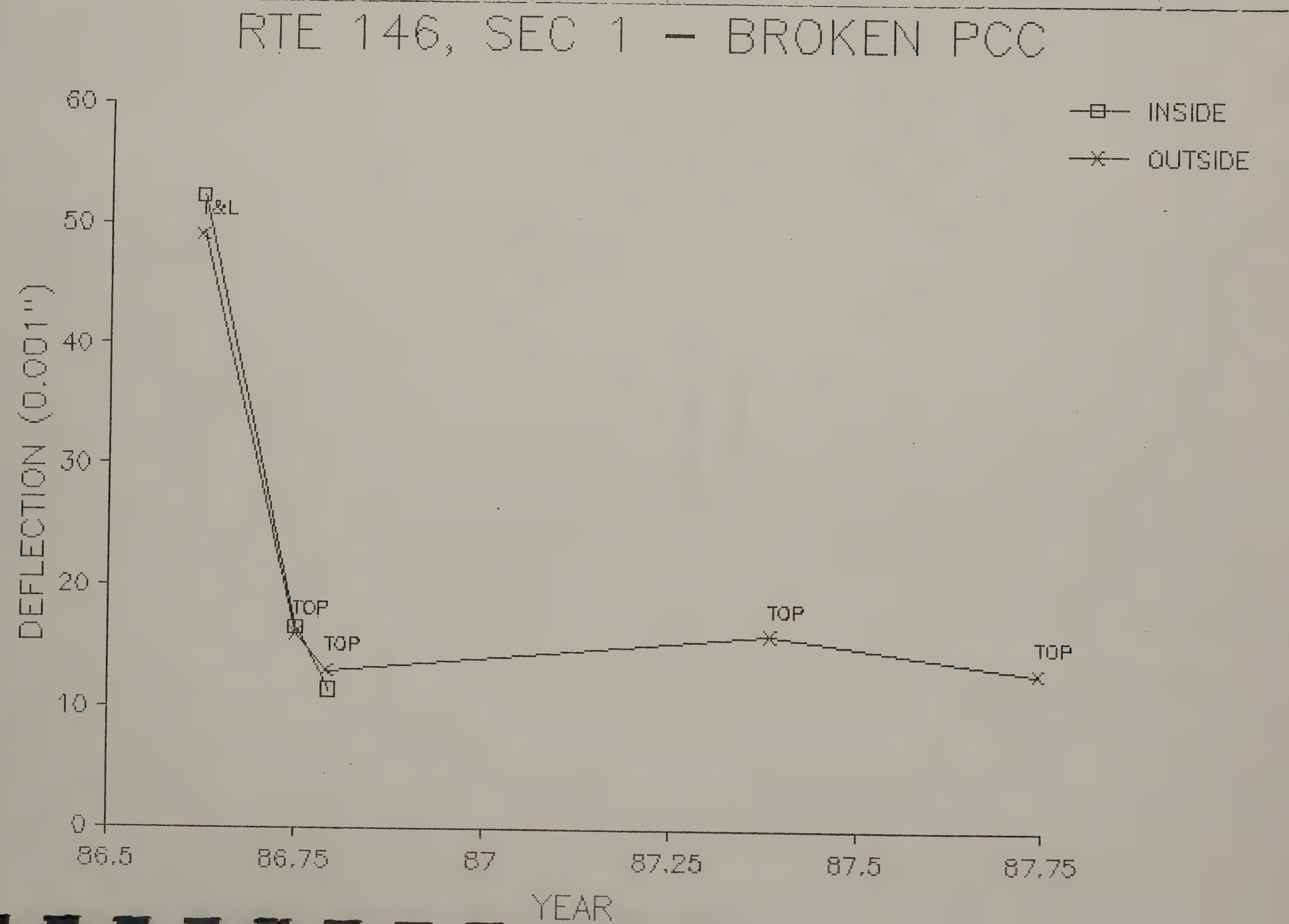
BASIS OF PAYMENT

The unit price bid per square yard shall include the cost of furnishing all labor, materials and equipment necessary to rubbleize, suppress dust, fill depressions, remove exposed mesh, compact and maintain the compacted condition of the existing pavement before the initial asphalt concrete overlay course is placed.

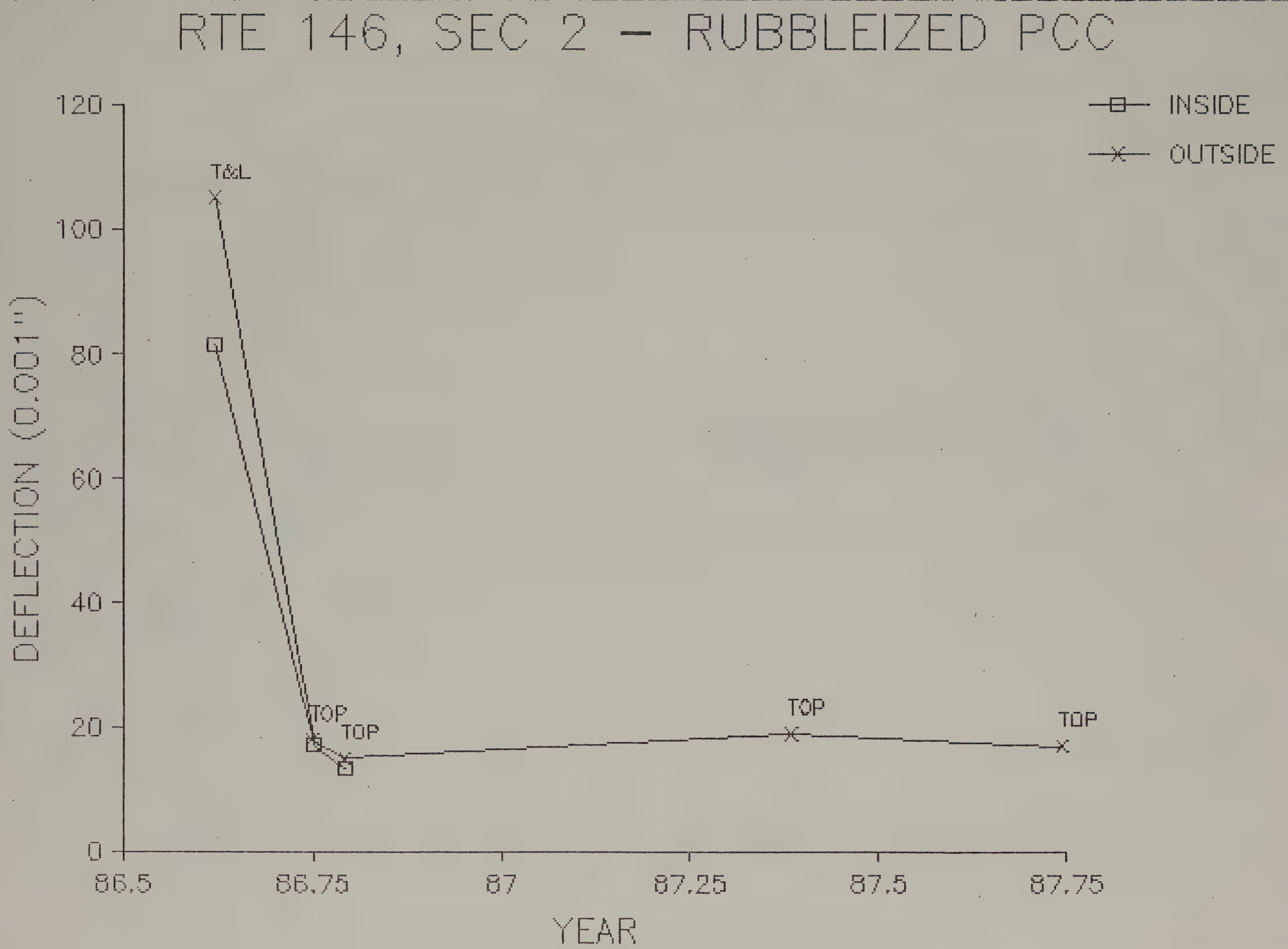
1/86

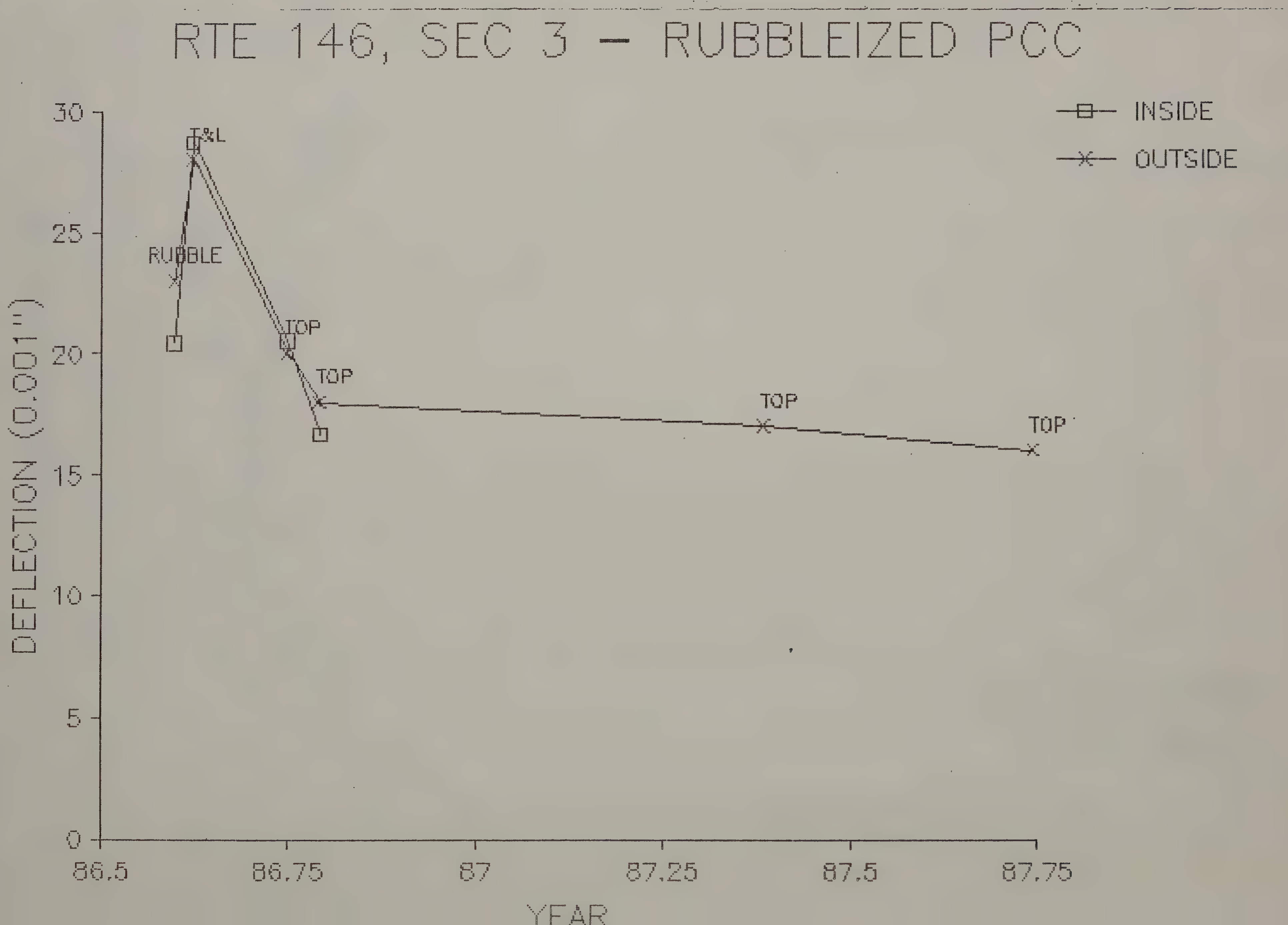
APPENDIX B

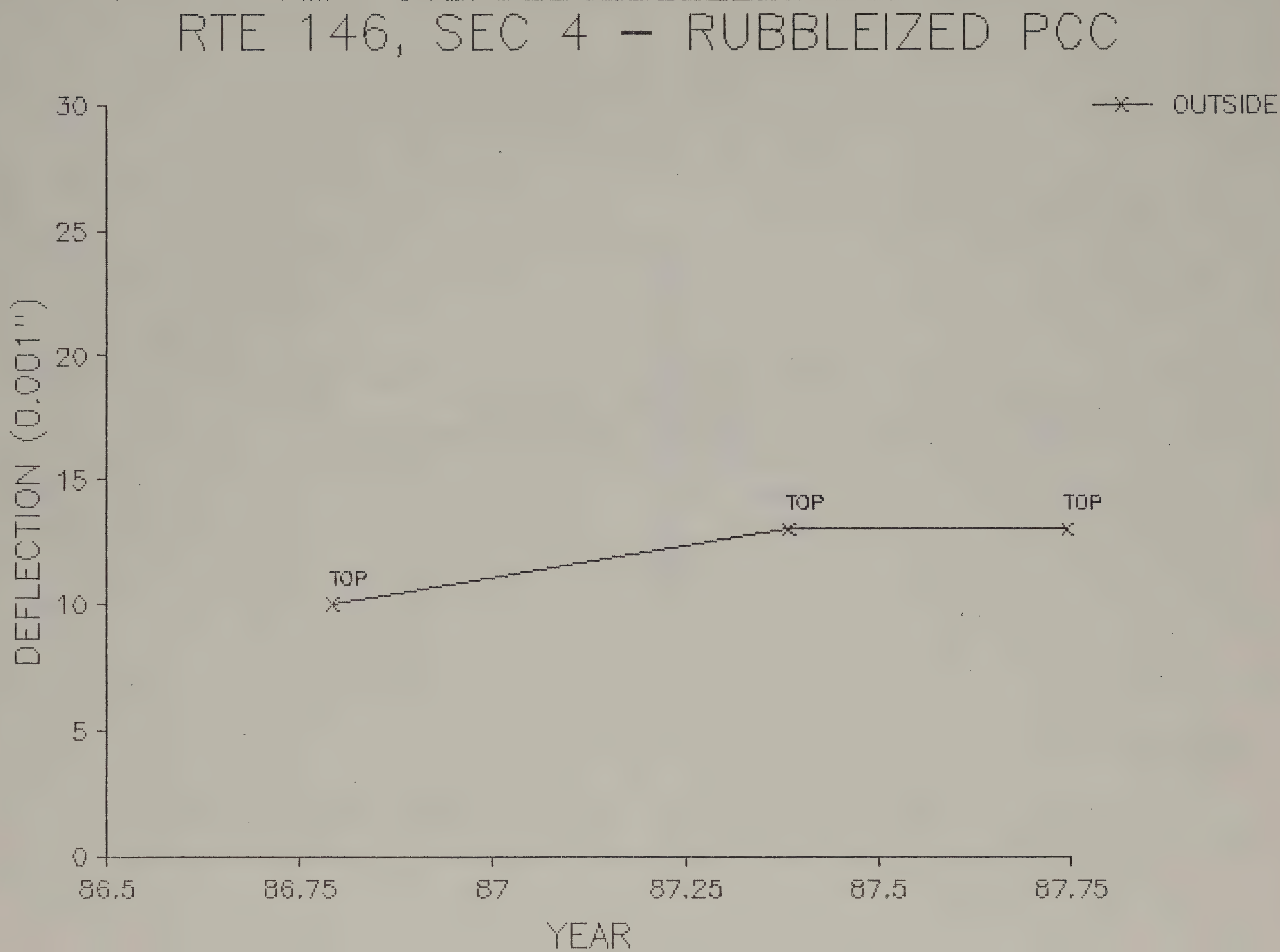
DEFLECTION DATA



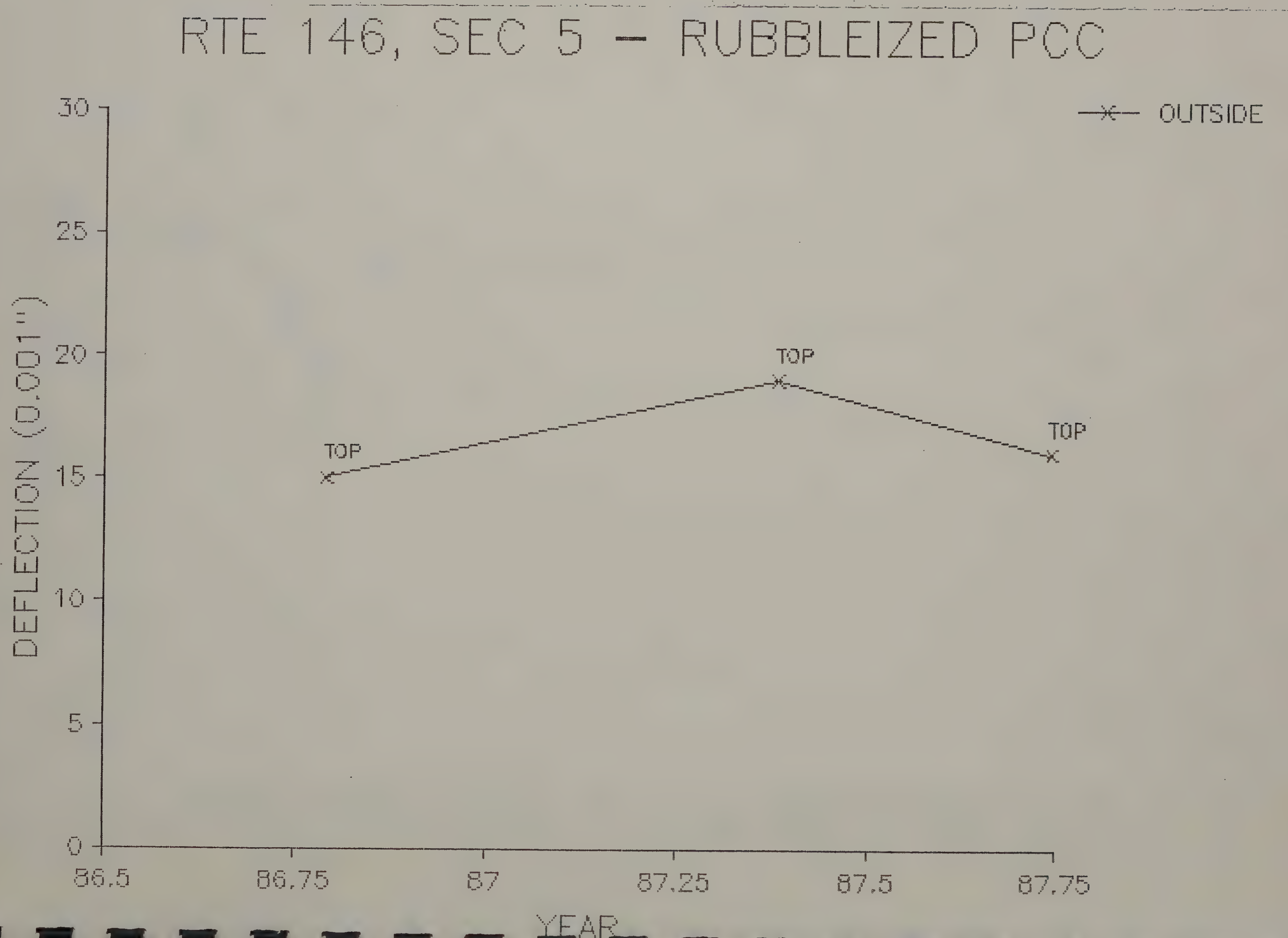
RTE 146, SEC 1 - BROKEN PCC
INSIDE
OUTSIDE
I&L
TOP
TOP
TOP
TOP
DEFLECTION (0.001")
0
10
20
30
40
50
60
86.5
86.75
87
87.25
87.5
87.75
YEAR


RTE 146, SEC 2 – RUBBLEIZED PCC
INSIDE
OUTSIDE
T&L
TOP
TOP
TOP
TOP
DEFLECTION (0.001")
120
100
80
60
40
20
0
86.5
86.75
87
87.25
87.5
87.75
YEAR


RTE 146, SEC 3 - RUBBLEIZED PCC
INSIDE
OUTSIDE
RUBBLE
T&L
TOP
TOP
TOP
TOP
DEFLECTION (0.001")
YEAR
30
25
20
15
10
5
0
86.5
86.75
87
87.25
87.5
87.75



RTE 146, SEC 4 – RUBBLEIZED PCC
OUTSIDE
DEFLECTION (0.001")
30
25
20
15
10
5
0
TOP
TOP
TOP
86.5
86.75
87
87.25
87.5
87.75
YEAR


RTE 146, SEC 5 - RUBBLEIZED PCC
OUTSIDE
DEFLECTION (0.001")
30
25
20
15
10
5
0
TOP
TOP
TOP
86.5
86.75
87
87.25
87.5
87.75
YEAR

APPENDIX C

SEISMIC MONITORING OF VIBRATIONS

MEMORANDUM
DEPARTMENT OF TRANSPORTATION

TO: Edward A. Fernau, Associate Soils Engineer

FROM: Joseph G. Jones, Assistant Engineering Geologist JGJ TRd

SUBJECT: SEISMIC MONITORING OF VIBRATORY PAVEMENT BREAKER
PIN 1085.16.301
SARATOGA COUNTY
TOWN OF CLIFTON PARK
RTE. 146

DATE: October 8, 1986

On August 5, 12 and 13, 1986, J. G. Jones, Assistant Engineering Geologist, M. P. Vierling, Assistant Engineering Geologist and T. Bender, Assistant Soils Engineer, all of Main Office Soils monitored vibration levels due to the operations of a vibratory pavement breaker on Rte. 146 in Clifton Park. The purpose of the monitoring was to determine the possible effect of the pavement breaking process on sensitive objects such as ceramic or cement pipes which might be buried beneath the road.

Monitoring was carried out at several locations along the length of the project. The basic monitoring configuration is described in Figure 1 and the results tabulated in Table 1. Figure 2 gives graphs of amplitude vs. distance for several locations, while Table 2 and Figure 3 give comparison results from a vibratory roller used as a follow up to the pavement breaker.

The frequency of the waves originating with the vibratory pavement breaker was approximately 45 HZ, while the vibratory roller gave about 30 HZ.

In general, the pavement breaker yielded a slightly lower velocity and amplitude than the vibratory roller. Also, the fall off with distance of vibration levels was at least as fast with the pavement breaker as with the vibratory roller. It may be concluded that the pavement breaker does not create a greater hazard to buried objects than the vibratory roller.

Table 1

Date: 8/13/86; Location: 100' East of EIC Trailer E.B. Lane
Offset from Rd. 0.5', breaker foot 0.5' from pavement edge.

Actual Distance	Velocity
(-) 50	0.25 in/sec
(-) 40	0.3
(-) 10	1.0
1	1.4
10	1.0
40	0.35
50	0.3
90	0.1
100	0.1

Date: 8/12/86; Location: Station 92.40 E.B. Lane
Offset from Rd. 5', breaker foot on edge of pavement.

Actual Distance	Velocity
(-) 50	0.5 in/sec
(-) 40	0.6
5	1.1
50	0.45
100	0.1

Date: 8/12/86; Location: Station 92.40 E.B. Lane
Offset from Rd. 20', breaker foot 1' (approx.) from edge of pavement.
Geophone was on rock.

Actual Distance	Velocity
(-)102	0.05 in/sec
(-) 54	0.15
21	0.20
54	not obtained
102	0.05

Date: 8/5/86; Location: Station 23+00 E.B. Lane
Offset from Rd. 10', breaker foot 1' from pavement edge.

Actual Distance	Velocity
(-)100	0.1
(-) 52	0.3
11	1.05
52	0.3

Date: 8/5/86; Location: Station 23+00 E.B. Lane
Offset from Rd. 1', breaker foot 4' from edge of pavement.

Actual Distance	Velocity
(-)100	0.1
(-) 50	0.5
5	1.1
50	0.7
100	0.35

Date: 8/5/86; Location: Station 23+00
Offset from Rd. ½', breaker foot on edge of pavement.

Actual Distance	Velocity 1st Run	Velocity 2nd Run
(-)100	0.1 in/sec	0.1 in/sec
(-) 50	0.6	0.6
1	1.35	1.3
50	0.6	0.6
100	0.1	

Date: 8/5/86; Location: Station 23+00 E.B. Lane
Offset 30' from edge of pavement, breakerfoot near edge of pavement, Goephone in sand bank.

Actual Distance	Velocity
30	1.0 in/sec
58	0.4
104	0.15

Table 2

Date: 8/13/86; Location: 100' East of E.I.C. Trailer E.B. Lane.
Geophone 10' from edge of pavement.
Vibratory roller from west.

Actual Distance	Velocity
(-)100	0.15 in/sec.
(-) 51	0.6
10	2.0
51	0.6
100	0.1

Date: 8/13/85; Location: 100' East of E.I.C. Trailer E.B. Lane.
Geohone at edge of pavement.
Vibratory roller from west.

Actual Distance	Velocity
(-)100	0.1 in/sec.
(-) 90	0.1
(-) 50	1.5
(-) 40	1.6
(-) 10	2.1
1	2.5
10	2.0
40	1.35
50	1.1
90	0.15
100	0.1

JGJ:NLW

APPENDIX D

NOISE MEASUREMENT DATA

NOISE MEASUREMENT DATA
MATERIALS BUREAU
RTC RESONANT PAVEMENT BREAKER

AUGUST 4, 1986

BACKGROUND LEVEL (no traffic): 58dBA
BACKGROUND LEVEL (w/traffic @ 25'): 78dBA (max.)

IDLING MODE:

	LEFT	RIGHT
25'	76dBA	-
50'	70dBA	-

BACKING MODE (w/warning beeper):

	LEFT	RIGHT
10'	94dBA (max.)	-
25'	91dBA (max.)	-
50'	89dBA (max.)	-

BREAKING MODE:

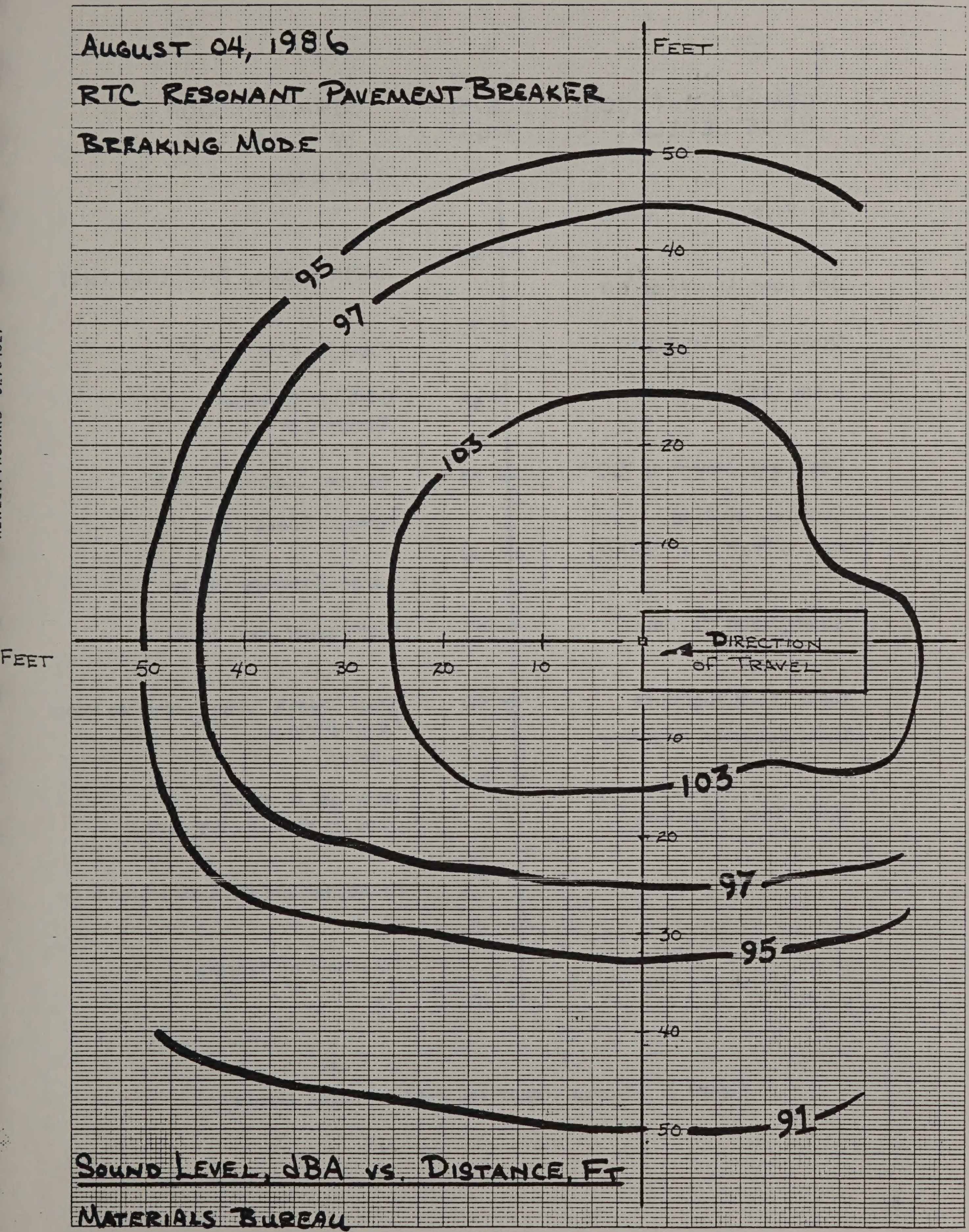
	LEFT	RIGHT
15'	103dBA (max.)	-
25'	97dBA (max.)	103dBA (max.)
50'	91dBA (max.)	95dBA (max.)

OPERATOR EXPOSURE (CAB):

Breaking	93dBA
Backing	84dBA (max.)

RATE OF TRAVEL:

Breaking	150 Ft/Min.
Backing	530 Ft/Min.


AUGUST 04, 1986
RTC RESONANT PAVEMENT BREAKER
BREAKING MODE
FEET
50
40
30
20
10
0
95
97
103
DIRECTION OF TRAVEL
FEET
103
97
95
91
SOUND LEVEL, dBA vs. DISTANCE, FT
MATERIALS BUREAU

OEP

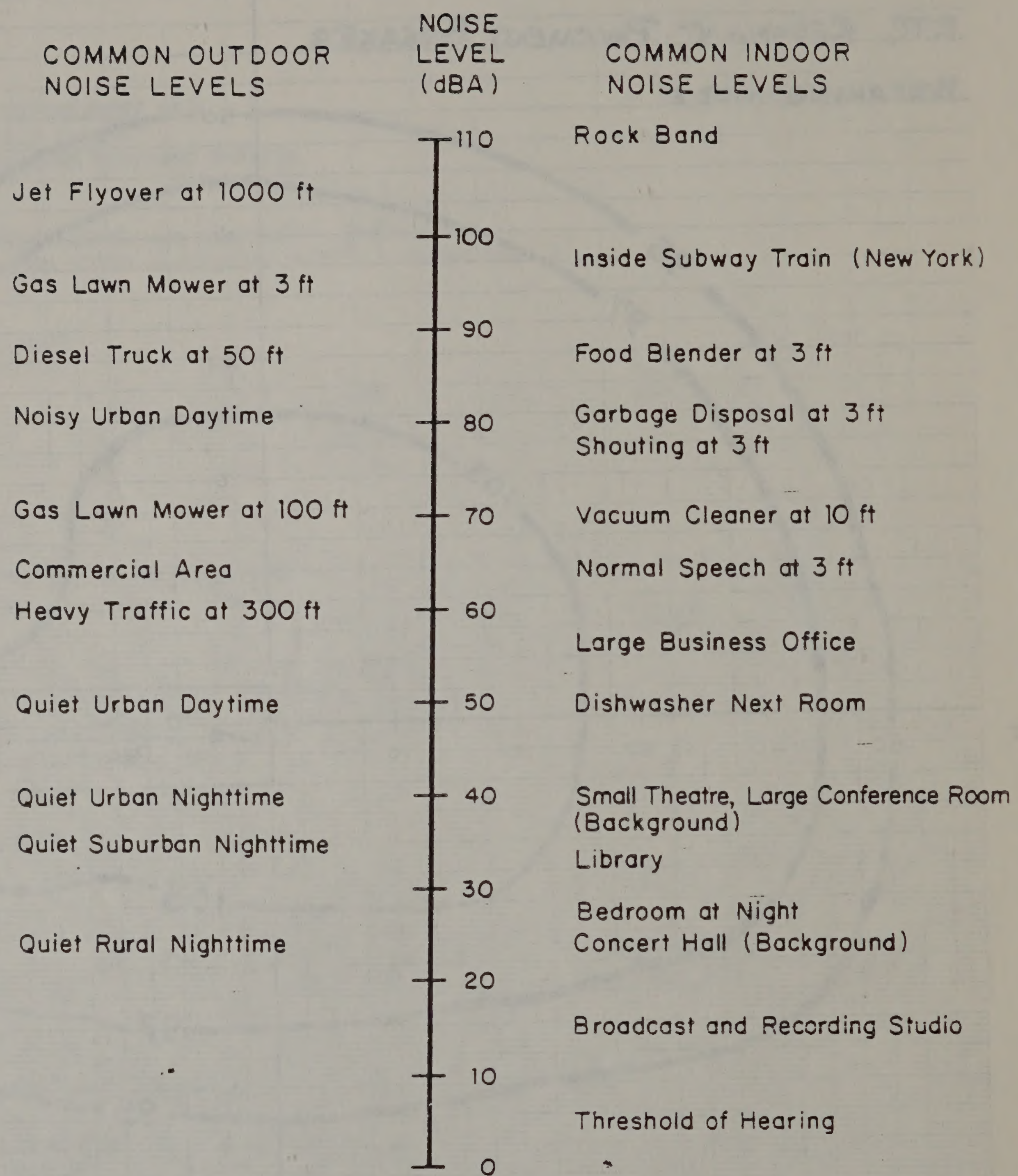


Figure 2. Common indoor and outdoor noise levels.